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EVALUATING TREATMENT CHALLENGES WITH DIFFERENTIAL REINFORCEMENT OF ALTERNATIVE BEHAVIOR

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In prior research, differential reinforcement of alternative behavior (DRA) has been implemented at optimal treatment values: Problem behavior is never reinforced, and alternative behavior is always reinforced. However, in application, DRA is unlikely to be conducted optimally. In this study, following a functional analysis phase and a differential reinforcement at full implementation phase, we challenged initially positive treatment effects for 3 participants by implementing DRA at less than optimal parameters. For example, some occurrences of problem behavior were reinforced, and some occurrences of alternative behavior were not reinforced. Results suggested that when exposed to DRA at full implementation, participants showed a bias toward appropriate behavior in subsequent conditions during which "mistakes" (treatment challenges) were intentionally introduced. In addition, the negative effects of treatment challenges were quickly reversible, in comparison to the positive effects of DRA, which were not quickly reversible in the face of treatment challenges.

DESCRIPTORS: functional analysis, differential reinforcement, aberrant behavior, treatment challenges

One of the most practical advantages of a pretreatment functional analysis is that the reinforcers that maintain problem behavior can be withheld during treatment (extinction) and presented contingent upon an alternative, more desired behavior (differential reinforcement). In general, when one behavior is placed on extinction and another behavior is reinforced, the procedure is called differential reinforcement of alternative behavior (DRA; Vollmer & Iwata, 1992). Functional communication training (FCT) is a good example of how information from a functional analysis may be applied to a DRA-based treatment: The reinforcer that maintains problem behavior can be withheld following occurrences of the problem behavior and presented following instances of communication (e.g., Carr & Durand, 1985). For example, if aberrant behavior is found to be reinforced by attention, FCT might involve placing aberrant behavior on extinction (ignoring) while providing attention contingent on appropriate mands (e.g., Hanley, Piazza, Fisher, Contrucci, & Maglieri, 1997). Similarly, if aberrant behavior is maintained by escape from instructional de-

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mands, aberrant behavior may be placed on extinction (e.g., working through the task) while an alternative behavior (perhaps compliance or communication) is negatively reinforced with a brief escape period (Lalli, Casey, & Kates, 1995). When escape is used as a reinforcer, the differential reinforcement application is sometimes called differential negative reinforcement of alternative behavior (DNRA; Vollmer & Iwata, 1992).

Since the emergence of functional analysis methods (e.g., Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994), studies on differential reinforcement based on functional analyses have proliferated (e.g., Mazaleski, Iwata, Vollmer, Zarcone, & Smith, 1993; Steege, Wacker, Berg, Cigrand, & Cooper, 1990). In a DRA arrangement, appropriate and inappropriate behavior can be conceptualized as concurrent operants (Fisher & Mazur, 1997). If the reinforcement schedule favors the alternative behavior, as it should in a well-designed DRA, responding should be allocated toward appropriate behavior and away from problem behavior. Typically, in evaluations of differential reinforcement, problem behavior is never reinforced (i.e., is placed on extinction), and defined instances of the alternative behavior are reinforced to maximize the probability of response allocation in favor of the alternative behavior.

In controlled experimentation, it is important to ensure that treatments are conducted with perfect or near-perfect integrity because otherwise any noneffects may be attributed to procedural failures rather than to limitations of the treatment itself. However, in application, many DRA procedures are likely to be challenged with integrity failures. It is unlikely, for example, that all instances of alternative behavior will be reinforced or that all instances of problem behavior will fail to produce access to reinforcers. As such, both appropriate and aberrant behavior will likely produce intermittent access to reinforcers.

At one end of a continuum, a perfect integrity failure would occur if appropriate behavior was never reinforced and problem behavior was always reinforced. An analogue to such a failure is conducted in most baselines in functional analysis research: Problem behavior produces access to reinforcers and appropriate behaviors explicitly do not produce access to such reinforcers (e.g., Iwata, Pace, Kalsher, Cowdery, & Cataldo, 1990; Hanley et al., 1997; Lalli et al., 1995; Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993). At the other end of the continuum, perfect integrity for DRA would involve reinforcement of all appropriate behaviors (or at least reinforcement would occur systematically according to a prescribed intermittent schedule) and extinction of all instances of problem behaviors. In the middle of the continuum, a therapist (or parent or teacher) might display good treatment implementation with one component (e.g., reinforcing all appropriate communication) but poor implementation with the other component (e.g., continuing to reinforce problem behavior). Recently, Shirley, Iwata, Kahng, Mazaleski, and Lerman (1997) evaluated the effects of FCT with and without extinction. The reinforcement component was conducted with 100% implementation, while no extinction component was in place. Results showed that FCT was ineffective without extinction unless FCT without extinction followed a condition in which FCT with extinction had been in place.

To date, no studies have evaluated methods for examining differential reinforcement effects along the continuum of perfect integrity failure to perfect integrity. In the study by Shirley et al. (1997), three general conditions were conducted: (a) alternative behavior was never reinforced and problem behavior was always reinforced (baseline), (b) alternative behavior was always rinforced

and problem behavior was never reinforced (full treatment), and (c) both alternative and problem behaviors were always reinforced (FCT without extinction). However, it is likely that when DRA-based procedures are actually applied, the reinforcement component for either alternative will be something between all or nothing. For example, a teacher may be inclined to usually reinforce compliance with escape and sometimes (intermittently) inadvertently reinforce escape-maintained self-injurious behavior (SIB). In such cases, the actual implementation of treatment might be something like the following: Alternative behavior is reinforced 80% of the time and problem behavior is reinforced 20% of the time. In this example, the treatment is implemented "correctly" 80% of the time. The effect of such treatment implementation is not known.

Although evaluation of varying treatment integrity values has been a frequent recommendation for behavioral intervention (e.g., LeLaurin & Wolery, 1992), few studies have evaluated methods to explicitly analyze treatment at less than perfect levels of integrity. In a notable exception, Northup, Fisher, Kahng, Harrell, and Kurtz (1997) reported a method for evaluating varying levels of treatment implementation for differential reinforcement plus time-out. In that study, an appropriate behavior was reinforced 100% of the time, 50% of the time, or 25% of the time. Also, aggression or pica was followed with time-out using those same implementation values. Results showed that initial treatment effects were maintained when time-out was implemented at 50%. Thus, there is evidence supporting the use of punishment procedures at reduced levels of implementation. The effects of differential reinforcement at eroded levels of implementation have not yet been evaluated.

In the current study, we evaluated a method similar to that used by Northup et al. (1997) to study differential reinforcement procedures (reinforcement and extinction) derived directly from a functional analysis. Following a functional analysis, problem behavior and appropriate behavior were treated as concurrent operants that were reinforced all of the time, never, or some of the time, depending on the condition. The specific purposes of the study were (a) to demonstrate a methodology by which initially successful DRA effects may be evaluated in the face of treatment challenges (subsequent less than optimal implementation) and (b) to evaluate the effects of treatment challenges on appropriate and problem behavior. If a method is available to evaluate DRA at implementation strengths that may mimic actual application, researchers and clinicians may be better able to identify critical treatment values. Further, if treatment produces positive effects in the face of less than optimal implementation, the prognosis for long-term efficacy and maintenance for differential reinforcement–based interventions is improved.

In addition to being practical, the manipulation of treatment implementation values might be of conceptual interest. To date, few studies have evaluated the differential responsiveness of inappropriate and appropriate behavior to new reinforcement schedules following treatments at full implementation. It would be useful to evaluate how changes in treatment fidelity of various degrees would influence inappropriate behavior in comparison to appropriate behavior. For example, it is possible that individuals would show a bias toward inappropriate behavior as a result of relatively long reinforcement histories. If this is true, inappropriate behaviors should readily return to high rates when they are intermittently reinforced or when appropriate behavior is not reinforced frequently enough. Conversely, it is possible that biases toward appropriate behavior would emerge, for instance, if the behavior is perhaps less painful or less effortful. If this

is true, appropriate behavior should be relatively slow to return to baseline levels following treatments implemented at full strength, and individuals should show a disproportional tendency to respond appropriately when reinforcement is simultaneously available for either inappropriate or appropriate behavior.

METHOD

Participants and Setting

Participants were 3 individuals who had been referred by their parents and teachers for treatment of severe behavior problems. Rachel was a 17-year-old girl who had been diagnosed with profound mental retardation and who engaged in SIB in the form of head hitting and hand biting and aggression in the form of scratching, hitting, and hair pulling. She was nonambulatory and used a wheelchair. She did not have conventional language skills and required assistance with all self-care routines. Todd was a 16-year-old boy who had been diagnosed with profound mental retardation and who engaged in SIB in the form of head hitting. He was nonambulatory and used a wheelchair. He did not use conventional language, but occasionally reached in the direction of desired items such as toys. Kyle was a 4-year-old boy who had not been formally diagnosed, but he appeared to be functioning in the severe to profound range of mental retardation. Kyle engaged in severe aggression in the form of hitting, scratching, and pulling hair. He had minimal speech and occasionally requested items by pointing or vocalizing one-word utterances. Rachel and Todd attended a school for individuals with profound handicaps. Kyle attended a noncategorical preschool program.

Sessions lasted 10 min and were conducted at the participants' schools in therapy rooms separate from their regular classrooms. Sessions were conducted three to five times per day, 3 to 5 days per week (no more than 4 days per week for Kyle, who did not attend school on Fridays). The therapy room in Rachel's and Todd's school contained a table, chairs, and items brought in by the therapist as needed for sessions. The therapy room for Kyle contained several tables and chairs and a chalkboard. It also contained books on shelves, but these were covered with sheets for sessions. Other materials were brought to the room by a therapist as needed for sessions.

Recording and Reliability

For Rachel's and Todd's sessions, observers were usually seated behind a one-way observation window but sometimes sat in the room unobtrusively. For Kyle's sessions, observers sat in a corner of the room at a table and did not interact with him. Behavior was scored using handheld computers. Inappropriate behavior included aggression and self-injury. *Aggression* was defined as hitting, pulling hair, scratching, or kicking the therapist. *Self-injury* was defined as self-hitting or self-biting (contact between the teeth and skin). Appropriate alternative behaviors were compliance (Rachel and Kyle) and mands (Todd). It is important to note that all targeted appropriate behaviors were present in the participants' repertoires prior to the study. Thus, no new alternative behaviors were shaped and no pretraining was required before entering into the differential reinforcement condition. *Compliance* was scored as completion of the requested task or task step either independently (no prompts) or following a verbal or gestural prompt. Compliance was not scored if physical guidance was used. *Mands* were scored as a reaching response with the hand and arm directed toward an item in the environment. Therapist behavior was also scored and included delivery of materials (handing a previously restricted item to the participant and allowing access for 30 $\pm$ 5 s), and delivery of escape

(stating "take a break" paired with 30 ± 5 s of break from instructional activity).

During 25.5% of the functional analysis sessions, a second observer simultaneously but independently scored the participants' problem behavior. Interobserver agreement calculations were the same as those used by Shirley et al. (1997). Specifically, interobserver agreement was calculated by dividing the 10-min session into 60 10-s intervals. The frequency of a target behavior scored by one observer was compared to the frequency observed by a second observer by dividing the smaller number by the larger number in each 10-s interval and converting to a percentage. The mean percentage of agreement was then used as an overall interobserver agreement score. Interobserver agreement averaged 98.6% (range for individual sessions, 90.8% to 100%).

During 60.6% of the baseline and treatment sessions, a second observer simultaneously but independently scored the participants' appropriate and inappropriate behavior. For inappropriate behavior, interobserver agreement averaged 97.9% (range for individual sessions, 88.3% to 100%); for appropriate behavior, interobserver agreement averaged 95.2% (range for individual sessions, 81.7% to 100%).

During 31.3% of the sessions, a second observer simultaneously but independently scored therapist behavior. Using the same calculation procedures described above, interobserver agreement for delivery of reinforcers (escape or materials) averaged 97.7% (range for individual sessions, 88.3% to 100%).

Functional Analysis

Functional analysis procedures were based on those of Iwata et al. (1982/1994). Four test conditions were conducted: attention, escape, materials, and no consequence. A fifth condition was designed as a control. During the attention condition, the participant had access to various materials but did not have access to attention unless the target aberrant behavior occurred. Aberrant behavior was followed by attention for approximately 30 s using a continuous reinforcement schedule (CRF). The attention consisted of a brief reprimand and then conversation. During the escape condition, a therapist presented instructions to perform a task based on the participant's individual education plan. The instructions were presented once per 30 s using a three-prompt sequence (verbal, gestural, physical guidance, with 5 s between prompts). Contingent on aberrant behavior, a 30-s escape period was introduced (using a CRF schedule) and was signaled by saying, "take a break." During the materials condition, a therapist started a session by removing preferred materials from reach. Contingent on aberrant behavior, the materials were presented to the participant for 30 s on a CRF schedule. During the no-consequence condition, the participant had no materials or other people with which or whom to interact; also, there was no programmed consequence for aberrant behavior. A therapist was in the room but did not respond to any target behaviors. The purpose of the attention, escape, and materials conditions was to evaluate possible reinforcement effects: If differentially high rates of aberrant behavior occurred during any one of these three conditions, the tested consequence was considered to be a reinforcer (Iwata et al., 1982/1994). The purpose of the no-consequence condition was to evaluate whether aberrant behavior would persist in the absence of socially mediated reinforcement. During the control condition, the participant had continuous access to preferred materials, attention was delivered at least once every 30 s, and no instructional demands were presented. The purpose of the control condition was to evaluate whether aberrant behavior persisted when all establishing operations from the test conditions

had been eliminated (i.e., no restricted access to attention or materials, no instructional demands, no austere environment).

For Kyle, the functional analysis phase was somewhat abbreviated because of an anticipated shorter time of participation. His school year was scheduled to end within a few weeks.

Baseline

During baseline, the relevant test condition from the functional analysis was replicated until aberrant behavior occurred at a relatively stable rate or was on an upward trend. For Rachel and Kyle, the escape condition from the functional analysis was used as a baseline because their behavior had been shown to be sensitive to escape as reinforcement. For Rachel, the tasks used for the instructional sessions were towel folding and utensil sorting. For Kyle, the tasks used were puzzles and sorting by color or shape. For Todd, the materials condition from the functional analysis was used as a baseline because his behavior was sensitive to materials (musical toys) as reinforcement. In all cases, the alternative behaviors (compliance, mands) produced access to reinforcers 0% of the time (extinction) and aberrant behavior produced access to reinforcers 100% of the time (CRF). This schedule arrangement is typical in functional analysis research that is designed to evaluate differential reinforcement as treatment (e.g., Shirley et al., 1997; Vollmer et al., 1993). Hereafter, baseline contingencies will be referred to as 0/100 (percentage of reinforcement for appropriate behavior/percentage of reinforcement for inappropriate behavior).

Differential Reinforcement: Full Implementation

During the first differential reinforcement conditions, treatments were based on the outcome of the functional analysis: Aberrant behavior was placed on extinction and an appropriate alternative was reinforced with 30-s access to the reinforcer on a CRF schedule. For Rachel and Kyle, whose behavior was reinforced by escape, DNRA was implemented, in which the alternative behavior was compliance and a 30-s break was made contingent on compliance. A therapist saying "take a break" and moving away from the participant signaled breaks. During breaks, work items remained on the table so that independent appropriate behaviors could occur; however, no prompting to engage with work materials was administered. For Todd, whose behavior was reinforced by materials, DRA with positive reinforcement was implemented, in which the alternative behavior was a mand (reach). In all cases, alternative behavior produced access to the reinforcer on 100% of the trials (CRF) and aberrant behavior produced the reinforcer on 0% of the trials (extinction). This schedule arrangement represents treatment schedules that are characteristic of differential reinforcement at full implementation (e.g., Shirley et al., 1997). Hereafter, full implementation contingencies will be indicated as 100/0 (percentage of reinforcement for appropriate behavior/percentage of reinforcement for inappropriate behavior).

Differential Reinforcement: Partial Implementation

During subsequent differential reinforcement phases, treatments were intentionally eroded to mimic various extremes of treatment implementation integrity failures. In other words, not all appropriate behaviors were reinforced and some aberrant behaviors were reinforced. Various partial implementation schedules were evaluated, although no attempt was made to evaluate exhaustively all possible schedule arrangements or to control for all possible order effects. The purpose of this analysis was to evaluate the effects of treatment challenges after an initially effective treatment had been implemented.

To assist with correct delivery of scheduled reinforcement, observers and therapists held cards specifying which responses should be followed by reinforcement. In the 25/75 schedule, for example, one list was a series of appropriate response instances with one out of every four randomly specified as the reinforced response, and a second list was a series of inappropriate response instances with three out of every four randomly specified as reinforced responses. On occasion, a therapist was verbally prompted by an observer or other assistant to help ensure correct reinforcer delivery.

Design

The sequence of conditions and the parameters of partial implementation were different for all participants. For all participants, baseline and full treatment were implemented first to ensure that DRA was effective.

For Rachel, the order of conditions was 0/100 (baseline), 100/0 (full treatment), 0/100, 25/75, 100/0, 50/50, and 75/25. These conditions were selected because they represented treatment at 0% strength (baseline), 100% strength (full treatment), 25% strength (25/75), 50% strength (50/50), and 75% strength (75/25). The order of conditions was selected in an attempt to evaluate lower implementation values first (other than full implementation).

For Kyle, the order of conditions was 0/100 (baseline), 100/0 (full treatment), 0/100, 100/0, 50/50, 25/75, 100/0. An attempt was made to test the same partial implementation values that were tested for Rachel, but in a different order. Because of time limitations, the 75/25 value was omitted.

For Todd, the order of conditions was 0/100 (baseline), 100/0 (full treatment), 0/100, 100/0, 20/0, 100/0, 100/100, 0/100, 100/0, 40/0, 100/0. These values were selected to evaluate a different model of partial implementation: Either one treatment component or the other (reinforcement or extinction) was always conducted with perfect integrity while the other component was implemented partially. At times in natural situations, one treatment component may be conducted perfectly while mistakes are made with the other component (e.g., always reinforcing communication but intermittently reinforcing the problem behavior, or intermittently reinforcing communication but always placing problem behavior on extinction).

RESULTS

Functional Analysis

Figure 1 shows the outcome of the functional analyses. For Todd, self-injury was observed only during the materials condition, suggesting that his behavior was sensitive to positive reinforcement in the form of materials (this outcome was summarized in a previous study by Vollmer, Marcus, Ringdahl, & Roane, 1995). For Rachel, inappropriate behavior occurred most consistently in the escape condition. For Kyle, aggression rates were highest in the escape condition, suggesting that escape reinforced the behavior.

Treatment Analysis

The upper panel of Figure 2 shows the outcome of Rachel's treatment analysis. During 0/100 (baseline), both appropriate and inappropriate behaviors occurred at high rates and increased as the condition progressed. During 100/0 (full treatment), appropriate behavior stabilized at a rate consistently higher than inappropriate behavior, which was extinguished during the final four sessions of the condition. During the return to 0/100, there appeared to be an extinction burst of appropriate behavior, which was no longer being reinforced. Inappropriate behavior was at 0 for six of the first nine sessions in the return to 0/100. During 25/75,

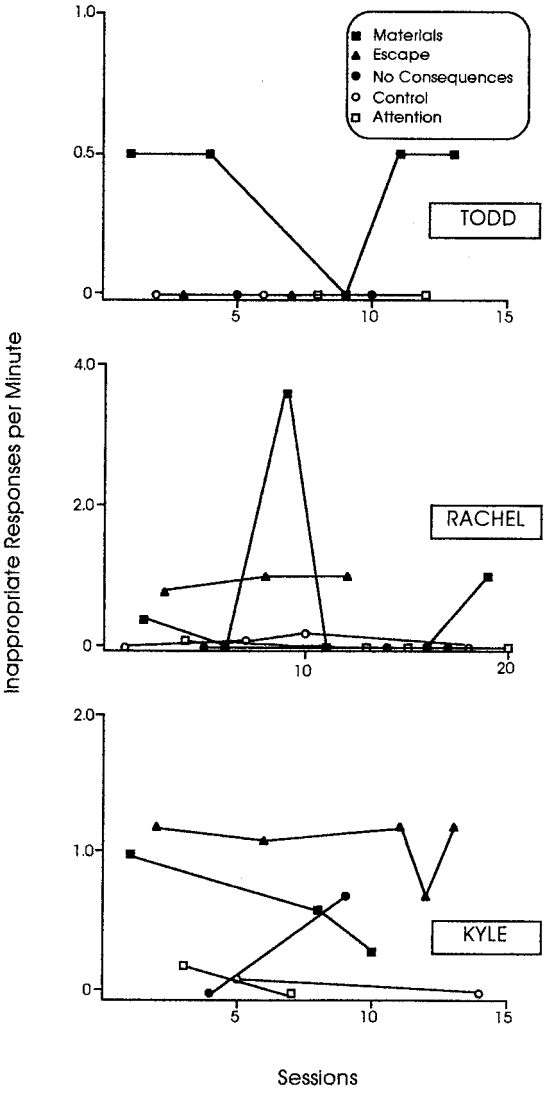

Figure 1. Results of the functional analyses for all participants. For Todd (upper panel), aberrant behavior was sensitive to positive reinforcement in the form of materials. For Rachel (center panel), aberrant behavior was sensitive to negative reinforcement. For Kyle (lower panel), aberrant behavior was sensitive to negative reinforcement.

there was an increasing trend in inappropriate behavior and a general decreasing trend in appropriate behavior. Upon returning to 100/0, inappropriate behavior never occurred and compliance occurred at a stable rate. During 50/50, compliance still occurred at a generally higher frequency than inappropriate behavior, but the effects were not as stable as had been noted at full treatment implementation. During 75/25, compliance stabilized and inappropriate behavior was at 0 during the final five sessions.

The lower panel of Figure 2 shows the response allocation of Rachel's appropriate and inappropriate behavior, plotted as a percentage of all responses (appropriate plus inappropriate). Five features of the data support a conclusion that Rachel showed a bias toward appropriate behavior. First, during baseline, appropriate behavior occurred at least as frequently as inappropriate behavior, despite the absence of escape as reinforcement for that behavior. Second, the transition from 100/0 to 0/100 yielded a very gradual change in response allocation; in fact, inappropriate behavior remained at 0 for six of the first nine sessions. Third, the transition from schedules favoring inappropriate behavior (e.g., 0/100 and 25/75) to the schedules favoring appropriate behavior (e.g., 100/0) yielded a very rapid change in response allocation; in fact, apparently because the very first instance of appropriate behavior contacted reinforcement during the second 100/0 condition, inappropriate behavior did not occur throughout the condition. Fourth, the transition from a condition in which appropriate behavior was never reinforced (0/100) to a condition in which appropriate behavior was reinforced unfavorably (25/75) produced an immediate temporary shift in response allocation toward appropriate behavior; no such immediate shift in response allocation toward inappropriate behavior was observed even in transitions to conditions in which every inappropriate behavior was reinforced and no appropriate behavior was reinforced (e.g., 0/100). Finally, when the probability of reinforcement was equal for inappropriate and appropriate behavior (i.e., 50/50), response allocation most consistently favored appropriate behavior.

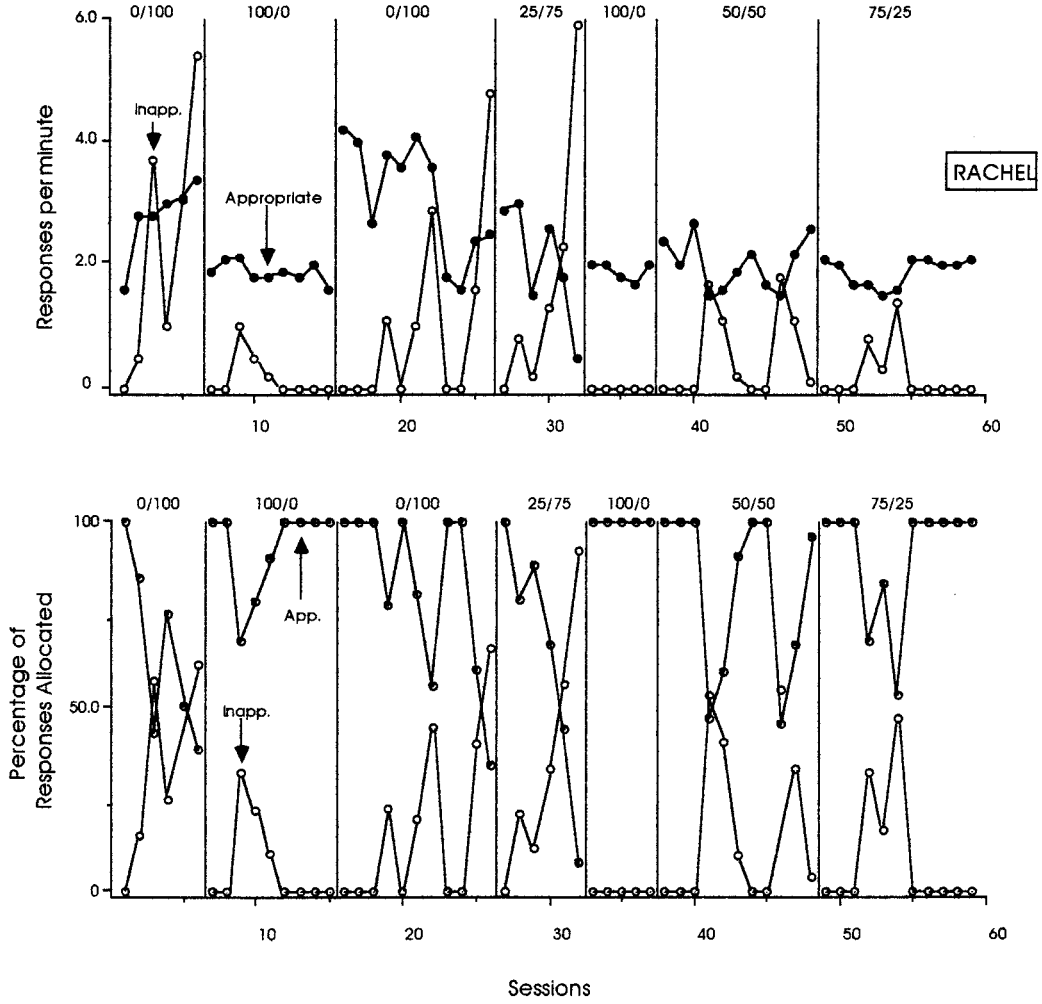

Figure 2. Results of the treatment evaluation for Rachel. Condition labels indicate the percentage of responses reinforced for both appropriate and inappropriate behavior (appropriate/inappropriate). The upper panel shows the number of responses per minute of appropriate and inappropriate behavior. The lower panel shows response allocation of appropriate and inappropriate behavior.

In the final condition (75/25), Rachel's response allocation was shifted exclusively to the appropriate behavior schedule for the final five sessions. This finding, combined with the general findings about a bias toward appropriate behavior, suggested that (a) differential reinforcement was resistant to treatment challenges, (b) treatment effects could be reobtained readily following treatment challenges, and (c) treatment probably would not need to be implemented at 100% to be successful.

The upper panel of Figure 3 shows the results of Kyle's treatment analysis. During all conditions except for the initial 0/100, appropriate behavior occurred at a higher rate than inappropriate behavior. However, the trends in the conditions that favored inappropriate responding (the second 0/100 and the 25/75) suggested that response allocation may have eventually shifted toward inappropriate behavior had the conditions been carried out longer (recall that Kyle's analysis was relatively abbreviated due to time constraints).

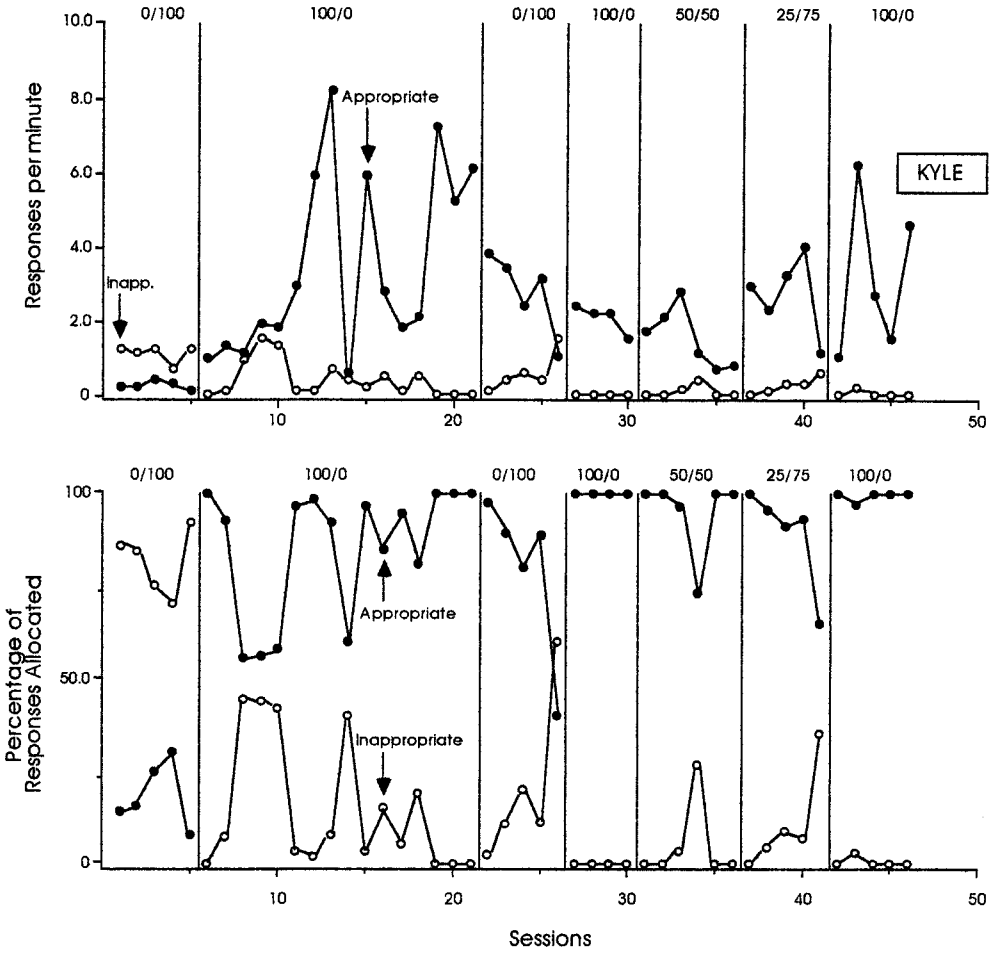

Figure 3. Results of the treatment evaluation for Kyle. Condition labels indicate the percentage of responses reinforced for both appropriate and inappropriate behavior (appropriate/inappropriate). The upper panel shows the number of responses per minute of appropriate and inappropriate behavior. The lower panel shows response allocation of appropriate and inappropriate behavior.

The lower panel of Figure 3 shows the response allocation of inappropriate and appropriate behavior as a percentage of total responses (inappropriate plus appropriate). As with Rachel, a preponderance of evidence suggested that Kyle showed a response bias toward appropriate behavior. During transitions into schedules that favored inappropriate behavior (e.g., from 100/0 to 0/100), the corresponding shifts in response allocation were gradual, whereas during transitions to schedules that favored appropriate behavior (e.g., 0/100 to 100/0), the corresponding shifts in response allocation were immediate. When the probability of reinforcement was equal (50/50), responding was allocated mainly to the appropriate behavior schedule. Given that responses were allocated primarily to appropriate behavior, DNRA was relatively resistant to implementation failures.

The upper panel of Figure 4 shows the results of Todd's treatment analysis. When treatment effects were obtained in the second 100/0 condition, all conditions that followed 100/0 conditions showed resistance to treatment challenges insofar as higher rates of appropriate behavior persisted even when the schedule favored inappropriate behavior (i.e., the third

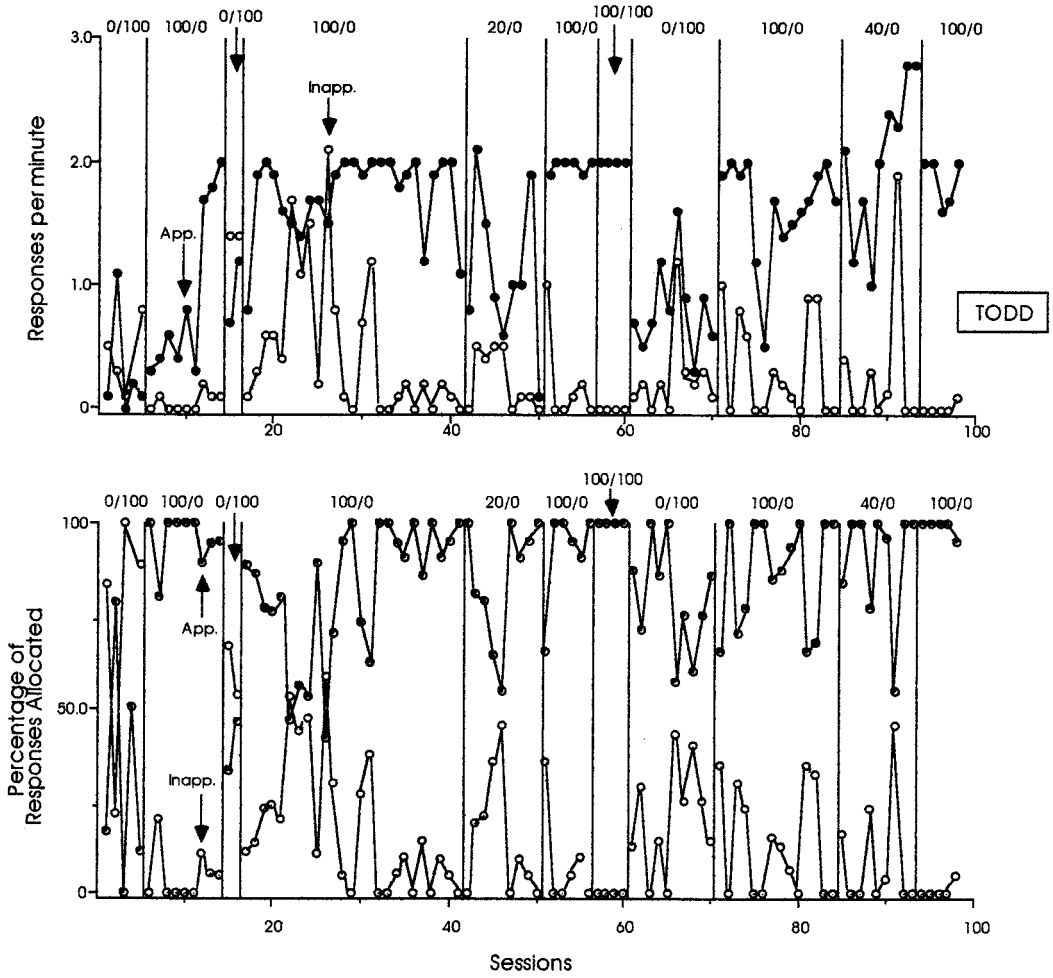

Figure 4. Results of the treatment evaluation for Todd. Condition labels indicate the percentage of responses reinforced for both appropriate and inappropriate behavior (appropriate/inappropriate). The upper panel shows the number of responses per minute of appropriate and inappropriate behavior. The lower panel shows response allocation of appropriate and inappropriate behavior.

0/100 condition). In the 20/0 and 0/100 conditions, raw rates of appropriate behavior were clearly affected by the unfavorable schedule, but the lower panel of Figure 4 shows that response allocation (plotted as a percentage of all responses) consistently favored appropriate behavior. Finally, the effects of the 100/100 condition, which followed a 100/0 condition, replicated the findings of Shirley et al. (1997) because responding was allocated exclusively to appropriate behavior following the immediately prior exposure to the 100/0 condition. Thus, although the planned arrangement was 100/100, SIB never contacted reinforcement in this condition because it never occurred. Shirley et al. had reported that FCT without extinction was effective if such a condition was preceded by FCT with extinction. For Todd, this effect was obtained because SIB did not occur at sufficient levels (i.e., anything greater than zero) to contact reinforcement.

DISCUSSION

In this study, differential reinforcement was evaluated at full implementation (all ap-

propriate behavior was reinforced and no aberrant behavior was reinforced) and in conditions that mimicked lower levels of implementation (some appropriate behavior was not reinforced, some inappropriate behavior was reinforced, or both). Taken as a whole, results suggested the following. At full implementation of differential reinforcement, inappropriate behavior was virtually replaced by appropriate behavior; lower levels of implementation eventually reduced treatment efficacy if the schedule of reinforcement favored inappropriate behavior, but there was a general bias toward appropriate behavior.

The disproportional tendency toward appropriate behavior was an unexpected finding, given that reinforcement histories for inappropriate behavior were presumably well established. However, the more recent histories with differential reinforcement of appropriate behavior may have disposed the participants to allocate responding in that direction. Even so, it is interesting that transitions to schedules favoring appropriate behavior produced almost immediate allocation shifts and transitions to schedules favoring inappropriate behavior yielded more gradual allocation shifts: The momentum of reinforcement effects differed as a function of whether reinforcement contingencies favored appropriate or inappropriate behavior. A review of our records showed that, in many sessions, the participants first engaged in appropriate behavior (e.g., Todd manded, Rachel and Kyle complied), perhaps several times, before resorting to inappropriate behavior. Thus, if early attempts to behave appropriately were reinforced, that form of responding would then persist.

We do not suggest that the bias toward appropriate behavior is a finding generalizable to all individuals who display severe aberrant behavior. Presumably, factors such as response effort may account for differential sensitivity to reinforcement of appropriate behavior in comparison to inappropriate behavior. For example, compliance may have been a less effortful response or may have taken less time for Kyle to emit in comparison to aggression. If a response bias toward aggression is identified in future work, the experimenters may wish to consider the possibility that the inverse is true: Latency to reinforcement for aggression often may be shorter than it is for compliance if the task is relatively complex. We did not measure latency to reinforcement in this study, but it could be a focus of future manipulations of implementation strength.

Similarly, for Todd, reaching (the communicative response) had no immediate aversive consequences, whereas SIB may have hurt. The pain produced by SIB may be tolerable if no other means of obtaining reinforcers are available (e.g., in the 0/100 condition), but response allocation may be disposed to shift if reinforcement is available for an alternative response that does not hurt and requires little effort. To date, little if any research has been conducted on such conjunctive consequences. Although the presumably punishing consequence of pain may be difficult to manipulate experimentally, many behavioral procedures may contain component consequences that are both reinforcing and punishing. For example, an attention-maintained problem behavior might simultaneously produce a reprimand (reinforcement) and response cost (punishment) in the form of contingent toy withdrawal. The reprimand and response cost are components amenable to experimental manipulation.

In experimental preparations of the sort used here, response allocation should not be expected to "match" the relative probability of reinforcement in the sense of Herrnstein's (1970) matching equation. When reinforcement is delivered on concurrent ratio schedules, organisms are likely to allocate nearly all responses to the richer ratio schedule if all other factors are held constant (Herrn-

stein & Loveland, 1975). In Rachel's case, for example, it should not be surprising that responses were exclusively allocated to appropriate behavior in the last five sessions of 75/25, an arrangement in which appropriate behavior was reinforced three out of every four times it occurred and inappropriate behavior was on a variable-ratio 4 schedule. Any time spent responding on the inappropriate behavior schedule would have reduced the momentary probability of reinforcement. However, the clear differential sensitivity to reinforcement of appropriate behavior cannot be accounted for entirely by richer ratio schedules. For example, Rachel's response allocation was exclusive (toward appropriate behavior) after just one session of 100/0 when that condition followed either 0/100 or 25/75, whereas response allocation was still not exclusive toward inappropriate behavior after 11 sessions of 0/100 in the reversal to baseline. Similar effects were seen with the other 2 participants. Future research should evaluate differential reinforcement at various degrees of implementation using interval-based schedules. Such analyses would be more amenable to evaluation of the matching law in relation to severe aberrant behavior.

From a clinical standpoint, the finding that partial treatment implementation can be effective following exposure to full implementation suggests the possibility of intentionally thinning implementation levels prior to generalizing a treatment plan into environments in which treatment fidelity will be difficult to maintain. Given that treatment effects may eventually erode, booster sessions might be conducted periodically to reestablish 100% implementation.

A clear limitation of the current analysis was that the order of conditions did not control for sequence effects. For example, it is unknown how Kyle would have allocated responding to the desired alternative in a 50/50 condition if his only prior experimental history was with 0/100. Nonetheless, the current study can be viewed as an evaluation of one method that could be useful in identifying critical treatment values after a participant has a history with full treatment implementation. Future studies, however, should evaluate the effects of less than optimal differential reinforcement procedures for individuals who have not been exposed to full treatment implementation. In addition, more within-participant replications of the various conditions and longer exposure to each condition should provide more information about schedule effects and transitions in response allocation.

Future work should also evaluate the manipulation of other variables that constitute full or partial treatment implementation. For example, treatment errors conceivably might involve delays to reinforcement rather than reinforcement intermittency. Perfect implementation of differential reinforcement presumably entails providing reinforcers as immediately as possible after an appropriate behavior occurs (e.g., within 5 s). Treatment effects may degrade as the delay to reinforcement increases, especially if inappropriate behavior is occasionally reinforced (and perhaps more immediately). Another example of differential reinforcement parameters that could be manipulated to test the effects of treatment challenges involves the duration of reinforcer access. The relative duration of escape, attention, or access to materials as a consequence to inappropriate and appropriate behavior could be manipulated parametrically to mimic treatment implementation failures. For instance, a parent may provide several minutes of attention for an injurious response (e.g., tending to a wound) but only a few seconds attending to appropriate behavior (e.g., providing a praise statement).

Thus, the methods from the current study could be adapted and expanded upon to evaluate numerous differential reinforcement parameters. The evaluation in the current

study suggests that differential reinforcement, at least when based on a prior functional analysis, can be quite resistant to treatment failures. However, the effects of recent and long-term reinforcement histories were not controlled in this study. In addition, other factors that influence response allocation (e.g., reinforcer delay, quality, duration, and magnitude) remain untested within a similar procedural format.

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STUDY QUESTIONS

1. Explain how a differential-reinforcement-of-alternative-behavior (DRA) contingency can be conceptualized as a concurrent-operant (choice) situation. Under such an arrangement, what is the typical programmed schedule of reinforcement for the two alternatives?

2. How does the concept of "treatment integrity" relate to the importance of studying the effects of parametric variations in DRA schedules?

3. What were the dependent variables and how were they defined?

4. Describe the contingencies in effect for aberrant and alternative behavior during the baseline and DRA conditions.

5. Why were the DRA integrity values selected for Todd somewhat different than those selected for Rachel and Kyle?

6. What were the results of the treatment analysis with respect to both aberrant behavior and alternative behavior during baseline, DRA (full strength), and DRA (partial integrity) conditions?

7. What aspect of the results was somewhat surprising? Why was it surprising? What four explanations do the authors provide to account for these findings?

8. Briefly describe several ways in which one might alter this experimental arrangement to further examine the effects of less-than-perfect implementation of differential reinforcement procedures.

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